

# AIR MOVEMENT OF CARGO AND CARGO



**612-520**

# **LOAD AND SECURE CARGO FOR AIR MOVEMENT**

## **REFERENCE**

**DOD 4500.9-R DEFENSE  
TRANSPORTATION REGULATION  
PART III MOBILITY**

# FUNDAMENTALS OF RESTRAINT

- RESTRAINT CONSIDERATIONS
  - GRAVITY FORCE “G”s
  - GROSS WEIGHT OF CARGO (ITEM)
  - RATE OF CHANGE” “SPEED”

# RESTRAINT CRITERIA

- ✱ **FORWARD** **3.0 G's**
- **AFT** **1.5 G's**
- **LATERAL (L/R)** **1.5 G's**
- **VERTICAL** **2.0 G's**

**C-130, C-141, C-5, C-17**

# **KC-10 AIRCRAFT NOTE**

**Forward restraint for KC-10  
is 9.0 G's without a barrier net.**

**Standard is 1.5 G's with barrier net  
installed.**

**All other directional restraint is the  
same as  
the other cargo aircraft.**

# RESTRAINT EQUIPMENT

- ◆ **CHAINS & DEVICES**

- **MB-1      10,000 LB**

- **MB-2      25,000 LB**

- ◆ **FITTINGS ( C-141  
ONLY )**

- **A-7000    10,000 LB**

- **A-2000    25,000 LB**

- **COMBINATION  
25,000 LB**

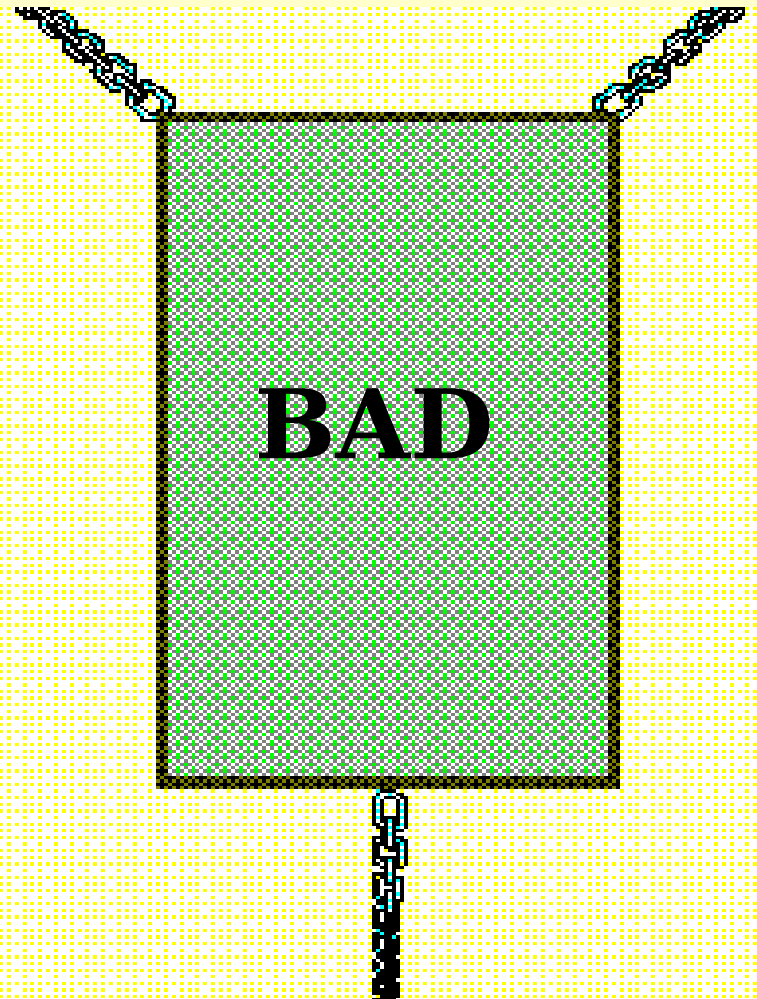
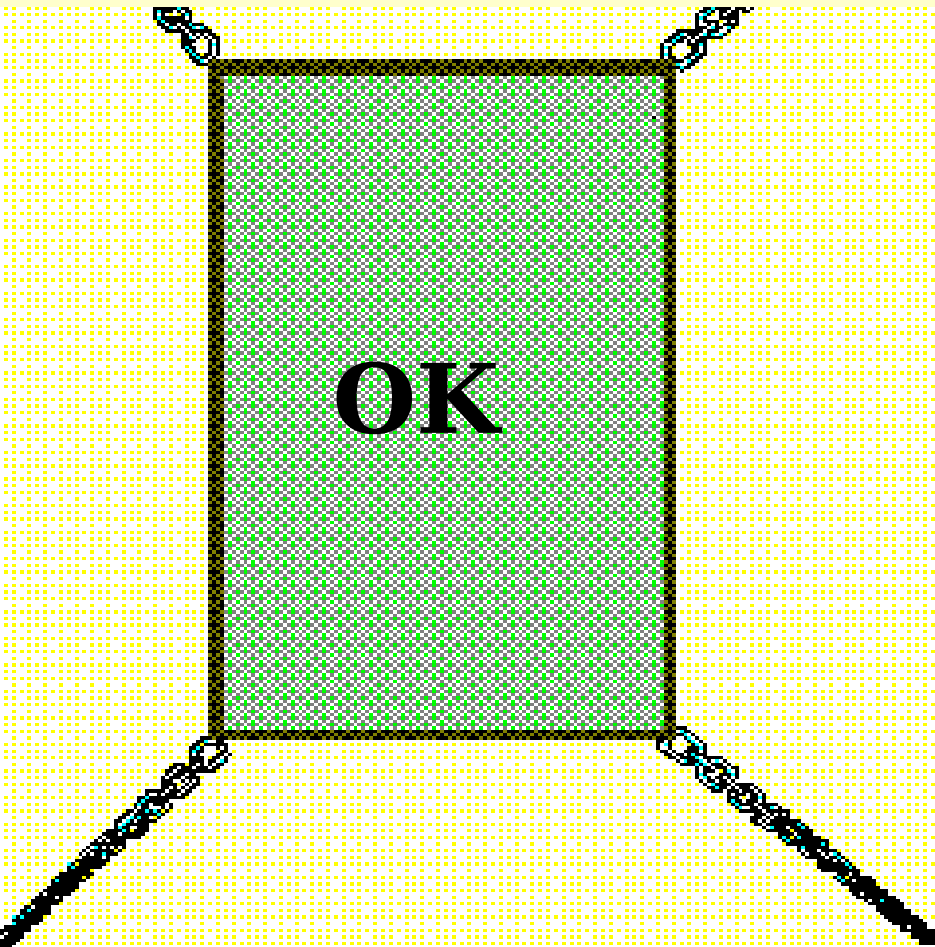
- ◆ **STRAPS**

- **COMBINATION    25,000 LB**

# **RULES OF APPLICATION**

- ◆ **Attain required directional restraint**
- ◆ **Attach symmetrically and in pairs**
- ◆ **Attach to primary points**
- ◆ **No more than half to axles - one direction**
- ◆ **Don't cross brake lines or cables**

# TIE-DOWNS NON-SYMMETRICAL

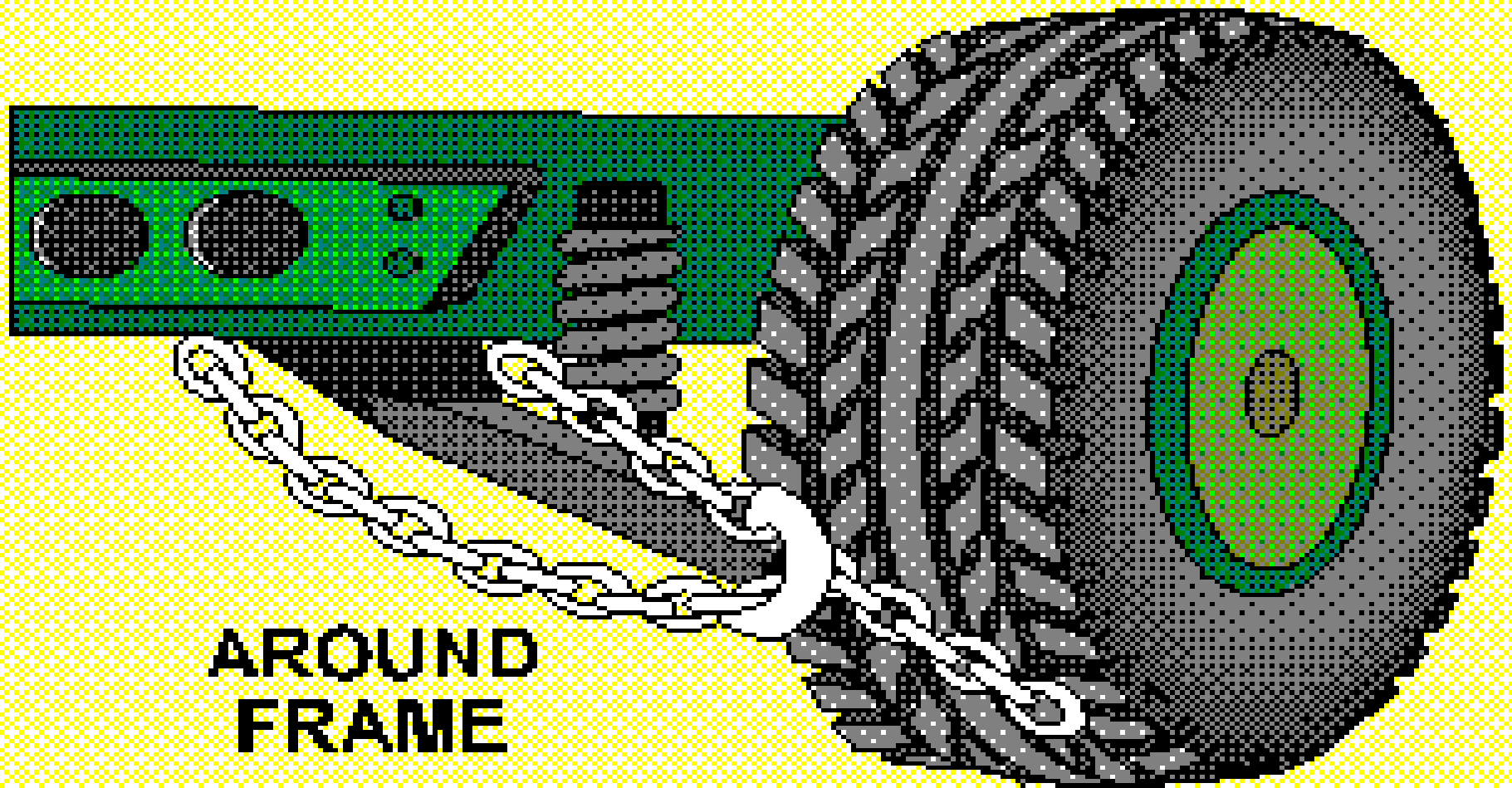




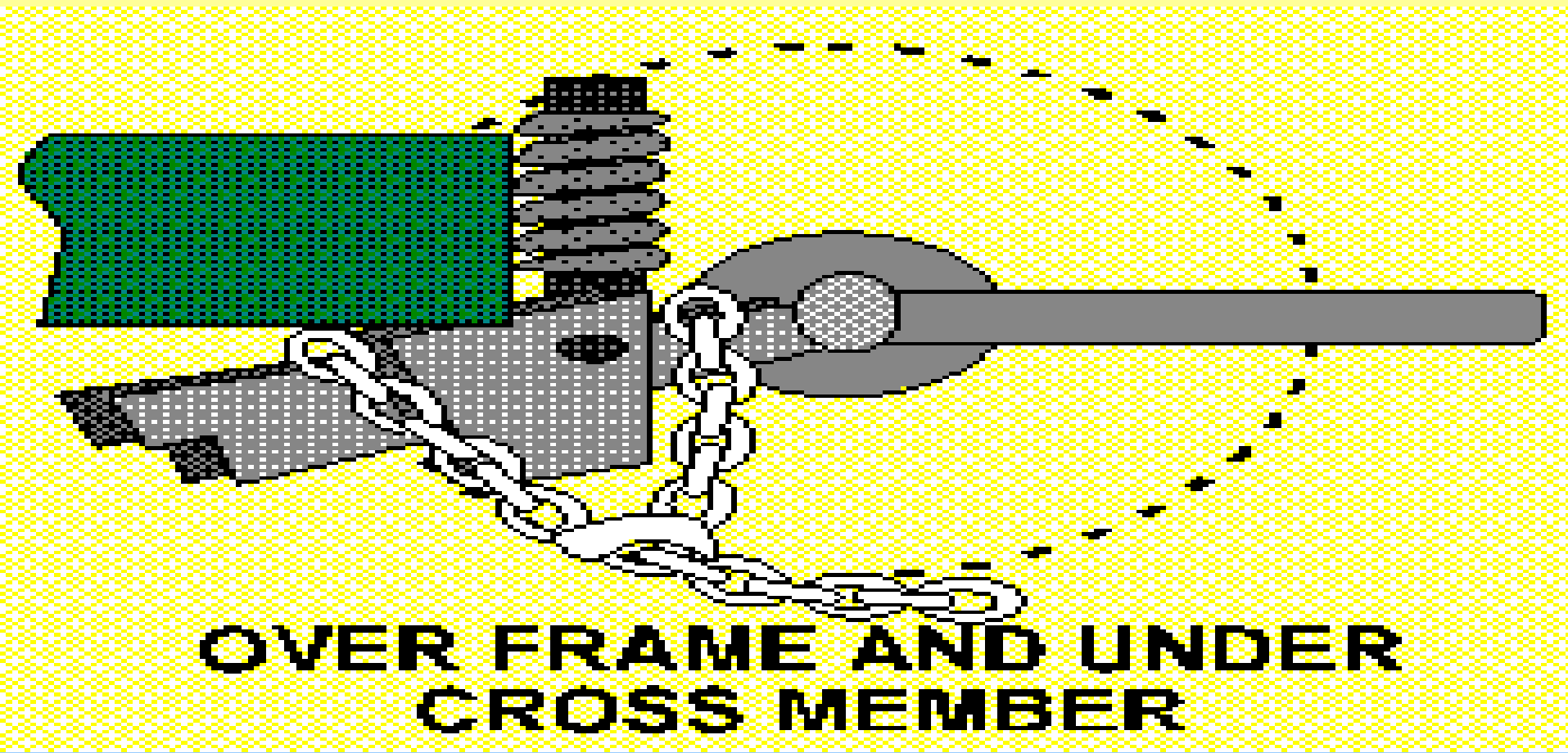
# ATTACHMENT POINTS

- **Bumper (Use clevises if installed)**
- **Frame**
- **Axle**

**Attach tie-down devices to designed tie-down points such as lifting shackles, if available. If they are not available use strong structural points such as frame members, bumper supports, or axles.**

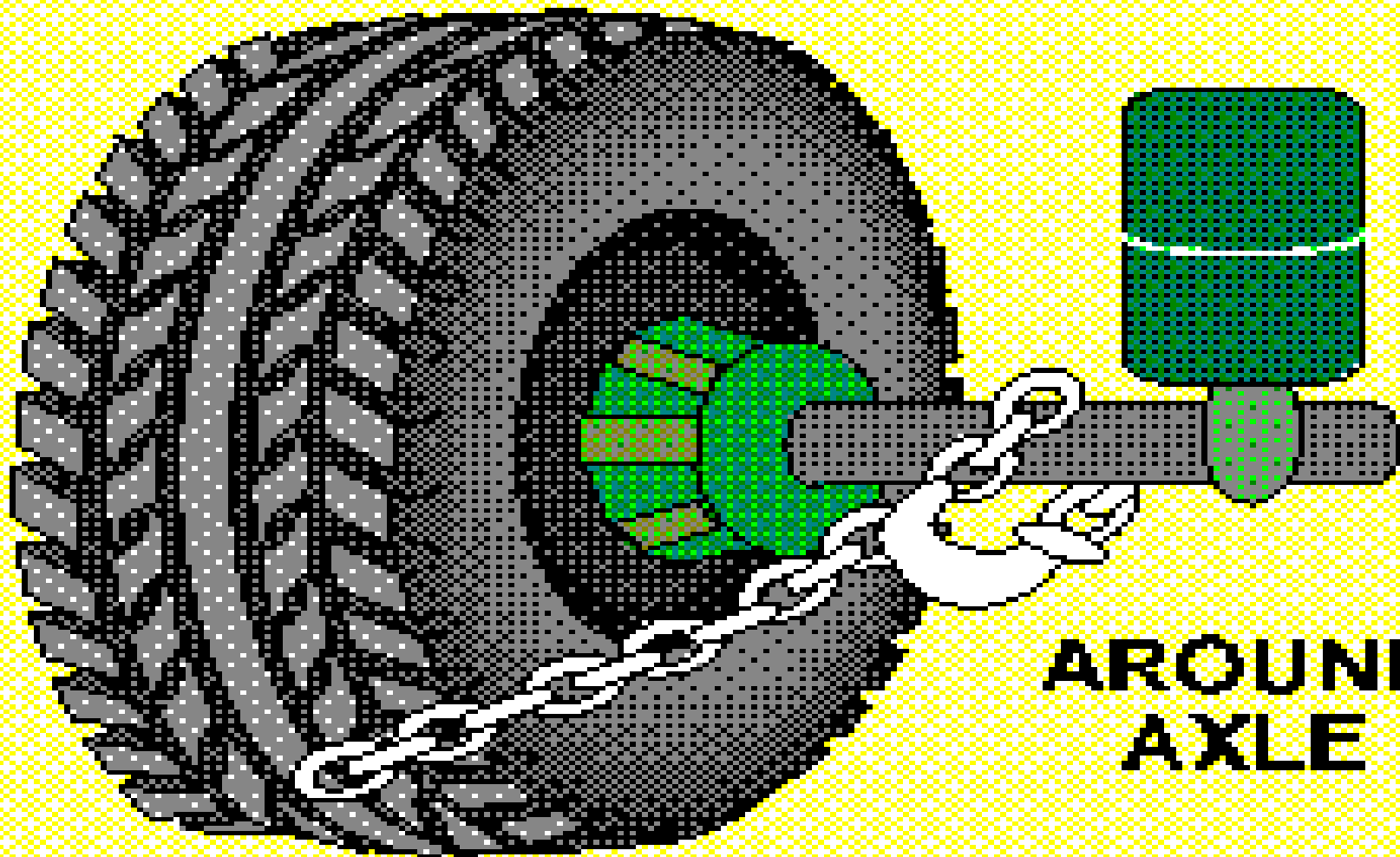


**Over the frame and under the cross member is similar to restraining the axle which mainly restrains unsprung weight (axles, tires, etc.) as opposed to restraining the frame which is sprung weight (all weight above the springs and axles).**



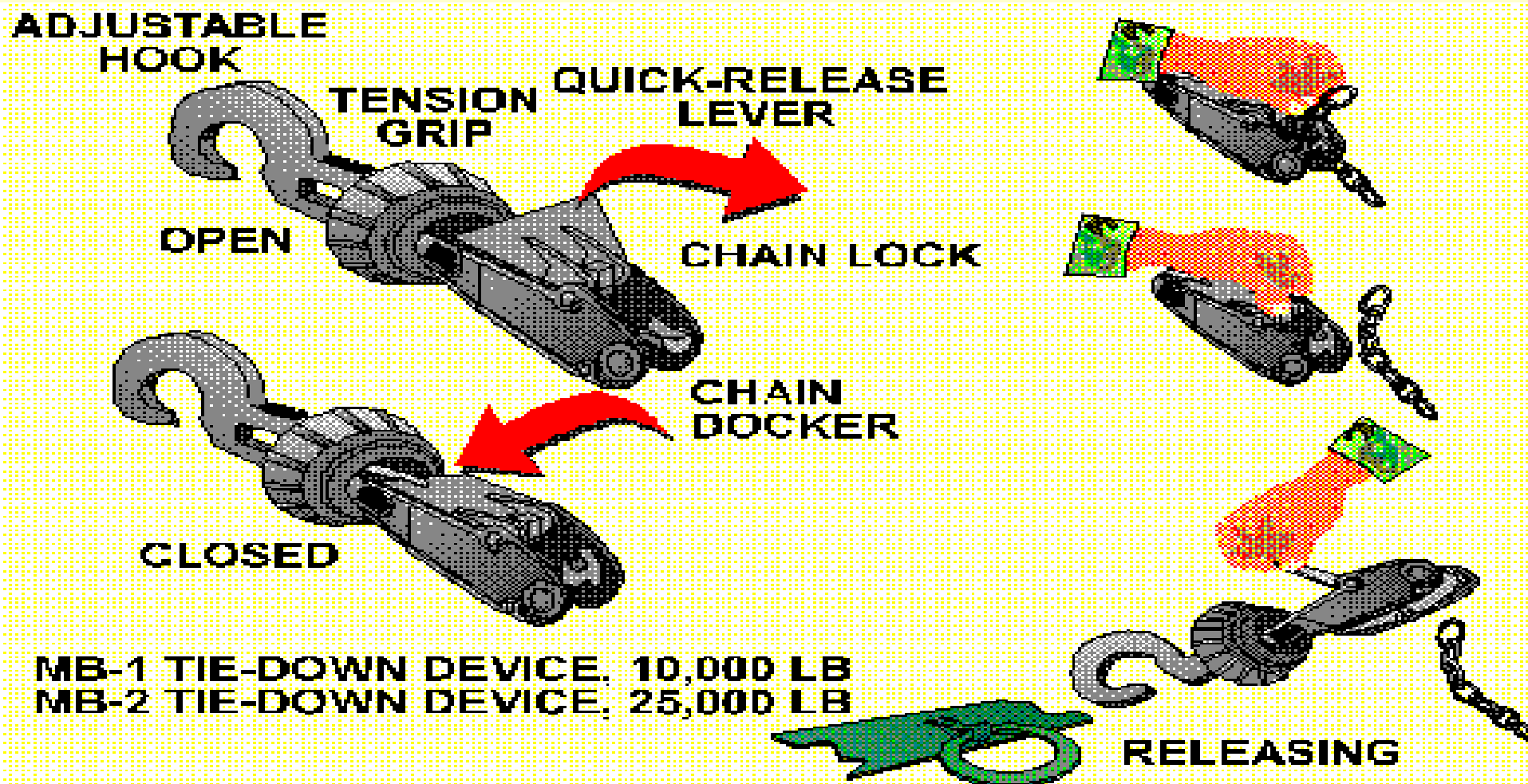
**When using the axle as a tie-down point, do not depend on friction or tension to prevent the chain from sliding.**

**Place the chains against something solid such as brackets or housings. Use no more than 50% of restraint on axles in any given direction, and do not crush air, hydraulic, or fuel lines.**



**AROUND  
AXLE**

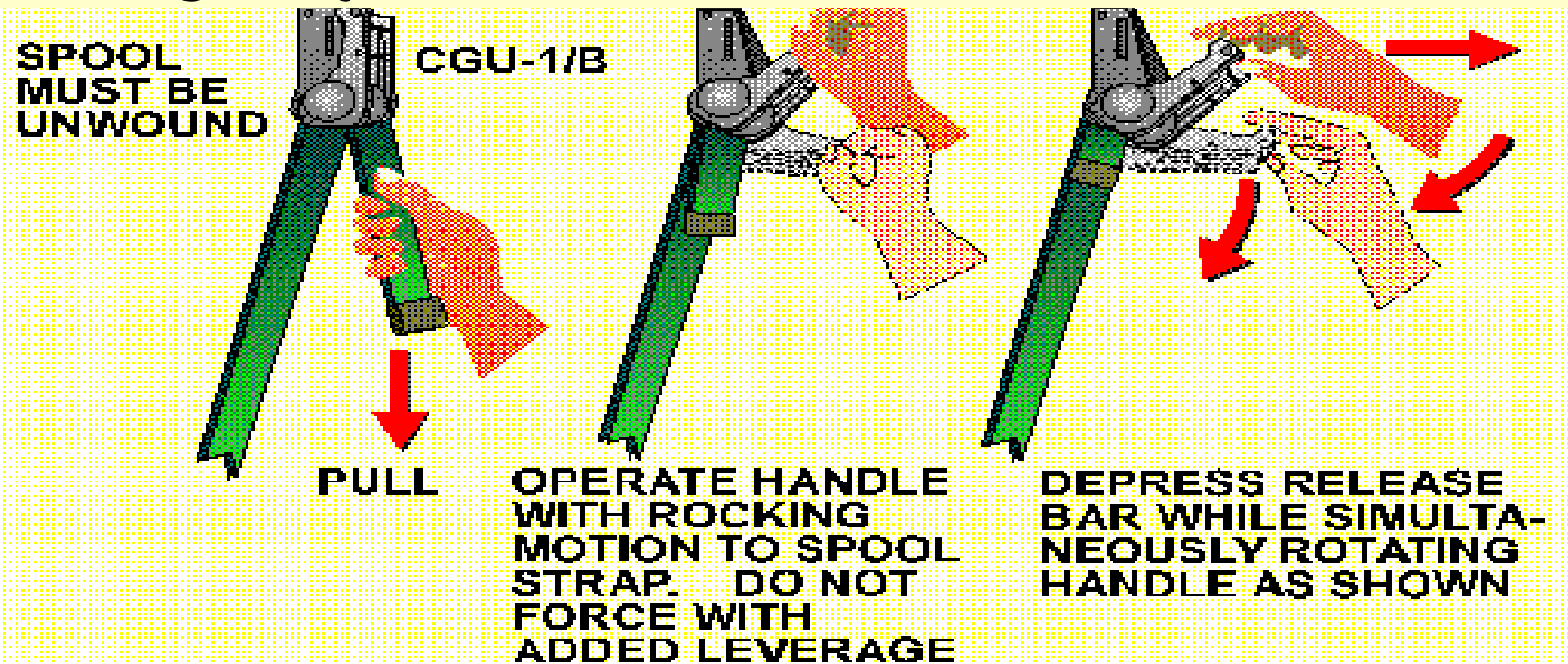
- Turn the rings in the floor and tie-down fittings so that tension is applied to the top of the ring.
- Attach the hook end of tie-down to aircraft floor & chain's hook to cargo.



# CGU-1/B CARGO STRAP

Use protective padding when using the CGU-1/B strap to secure cargo with edges.

Use cargo straps on cargo that may be damaged by chains.



# **PREFERRED ANGLES OF APPLICATION**

- **30 DEGREE PLAN & 30 DEGREE FLOOR  
ANGLE**

**(30 X 30)**

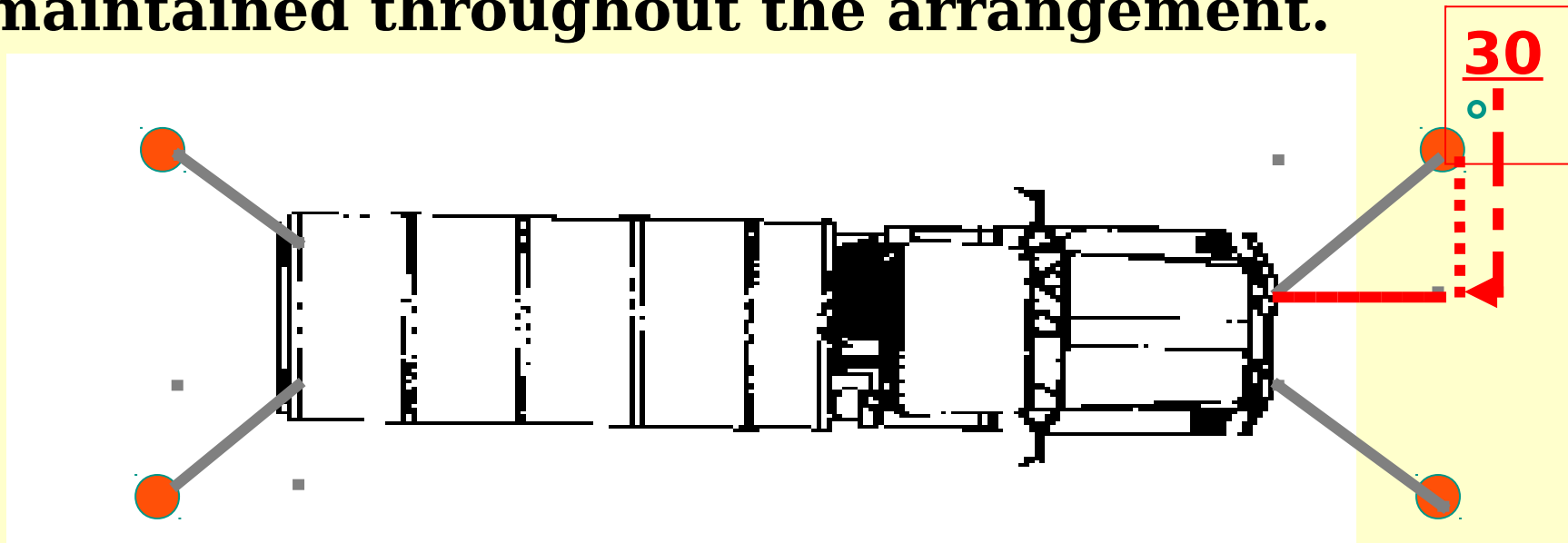
- **45 DEGREE PLAN & 45 DEGREE FLOOR  
ANGLE**

**(45 X 45)**

# TIE-DOWN PATTERN

Whenever possible, install tie down devices at an angle of  $30^\circ$  from the cargo floor and  $30^\circ$  from the longitudinal axis. Lead the tie-down directly from floor fitting to the load being controlled.

Tie-down devices and fittings must be equal strength.  
Tighten devices so that equal tension is maintained throughout the arrangement.

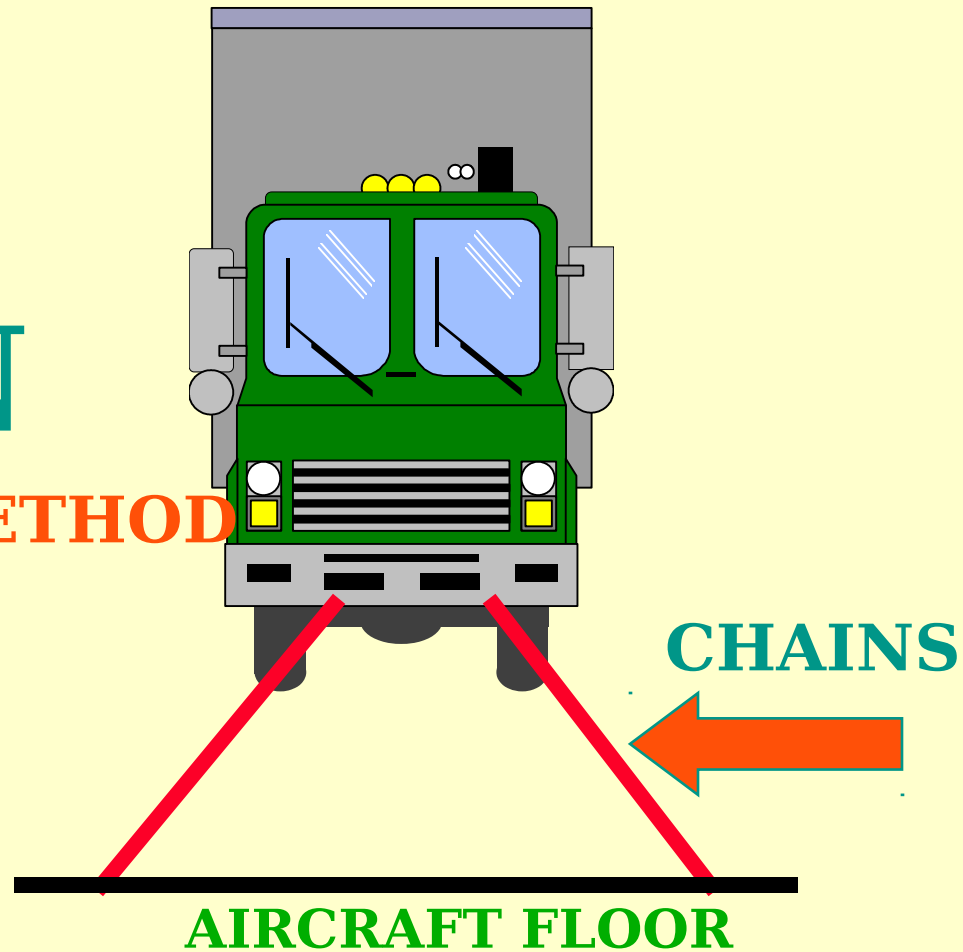




# METHODS OF APPLICATION

OPEN

PREFERRED METHOD

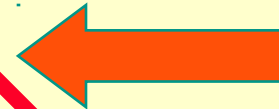
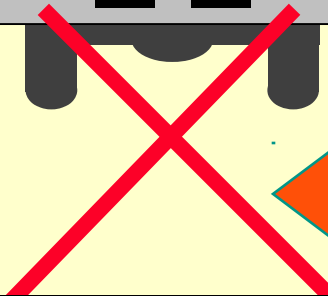
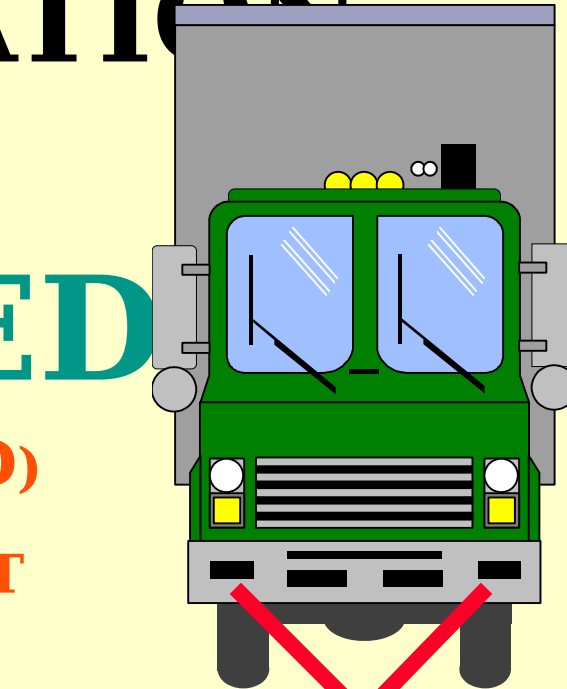


# METHODS OF APPLICATION

## CLOSED

(CROSSED)

WITH AIRCRAFT  
LOADMASTER  
APPROVAL



CHAINS

# PERCENT EFFECTIVENESS

- $30^\circ \times 30^\circ = 75 \%$
- $45^\circ \times 45^\circ = 50 \%$

# APPROXIMATE RESTRAINT

- 30° x 30° 10,000 lbs. x 75% = 7,500  
lbs.  
MB-1
- 30° x 30° 25,000 lbs. x 75% = 18,750  
lbs.  
MB-2
- CGU-1/B 5,000 lbs. x 75% = 3,750  
lbs.

# RESTRAINT FORMULA

RESTRAINT CRITERIA (G) x WEIGHT OF ITEM = # OF

**TIEDOWNS**

**APPROXIMATE RESTRAINT OBTAINED  
REQUIRED**

Take the directional restraint in Gs and multiply it by the gross weight of the item of cargo to be restrained. Then divide this number by the approximate amount of restraint coming from the tie-down chains/devices based on the angle applied (30x30 angle or 45x45 angle). The result is the number of chains needed (in even numbers) to secure the cargo for that given direction.

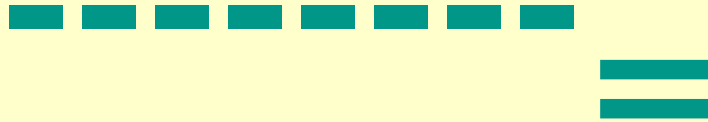
# SAMPLE APPLICATION

## OF FORMULA

(USING MB-1  
CHAINS/DEVICES)

$$\frac{3.0 \text{ G's FWD} \times 10,000 \text{ lb. item}}{7,500 \text{ LBS}} = \text{?} \text{ \# chains required}$$

# SAMPLE SOLUTION FOR FORMULA



- **REQUIRES**        **CHAINS**

# **SAMPLE PROBLEM**

## **SITUATION:**

**A 20,000 LB. VEHICLE IS TO BE  
RESTRAINED USING MB-2  
CHAINS AND DEVICES AT A 30°  
x 30° ANGLE.**

**HOW MANY CHAINS ARE  
REQUIRED ?**



# SAMPLE PROBLEM

RESTRAINT CRITERIA		CARGO WEIGHT	REQUIRED RESTRAINT	APPROX. % OF EFFECTIVENESS 75 %	#OF TIEDOWNS
FWD					
AFT					
LAT					
VERT					

# **SAMPLE SOLUTION**

**..... CHAINS REQUIRED - MINIMUM**



**IN GENERAL, PROPER  
APPLICATION OF  
FORWARD AND AFT  
RESTRAINT WILL SATISFY  
LATERAL AND VERTICAL  
RESTRAINT.**

**CONSULT WITH AIRCRAFT  
LOADMASTER FOR ANY  
ADDITIONAL RESTRAINT  
REQUIREMENTS.**

# **SUMMARY**

- **CRITERIA**
- **EQUIPMENT**
- **APPLICATION**
- **EFFECTIVENESS**
- **FORMULA**